about the thickness of a man's thumb, and were composed of firm and dense bone. The cartilages had disappeared, and a loose filamentous tissue occupied the interstices of the joint, Had the parts been kept straight, no union could have been firmer or more satisfactory. Thus it would seem that if the opposed surfaces of the femur and tibia are refreshed and united by wire, sufficient osseous substance may be produced to maintain firm union.

It seems that with care in the selection of cases, and especially in the performance of the operation and after treatment, that the proceeding known as erasion of the knee has a promising future before it, and may, in time, be recognized among the more satisfactory operations of conservative surgery.

ON THE ETIOLOGY AND ESSENTIAL NATURE OF SCOLIOSIS.

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THERE have been no thorough and elaborate investigations of the essential nature of scoliosis, which can compare with those of Miculicz into the pathology of genu valgum. But the points of resemblance between true lateral curvature and knock-knee are so strong that one is almost compelled to recognize in the known facts about the latter, the key to the true pathology of the former.

Fig 1 represents diagrammatically, a transverse, perpendicular section of the body of a vertebra in one of the curves of a scoliotic spine. It is wedge-shaped, with the apex of the wedge towards the concavity of the curve. There has evidently been inequality of development on the two sides of the main bony mass of the vertebra, analogous to the inequality in growth of the two sides of the diaphysis of the femur. (see Fig 2.)

The epiphyses are developed unequally in the same way. Just as in knock-knee the result is an angular curvation with the apex towards that side on which the bone has grown the faster, so in scoliosis, we have a lateral curvature with the convexity towards the side on which the vertebral bodies have grown the faster. However, in the latter case, the curvature is not angular but rounded, in consequence of a row of superimposed bones being similarly affected.

A number of wedges with straight sides can as, everybody knows, be arranged to form together a curved line, as in Fig 3, every single line of which is straight, but the whole produces an arc.

To see these facts in their true light it is necessary to realize that *more or less of this osseous deformity, of this wedge shaped alteration in the vertebral bodies, exists at the very first onset of the disease.* It is present in those cases of scoliosis which are only recognizable by the existence of the slightest possible

Fig. 1.

Fig. 2.

Fig. 3.

degree of projection of one shoulder-blade, or of one hip. It has been found in every specimen of scoliosis, mild or severe, in every museum in the world in which it has been looked for. It has been found to exist in a marked degree in specimens in which it has been declared to be absent, by surgeons who believe in such a thing as scoliosis of a muscular and ligamentous origin. Take, *e. g.*; specimen No. 521, of the Musée Dupuytren. Bouland has given careful and conclusive measurements of the asymmetry of the bones of this specimen, thus refuting statements of no less a surgeon than Malgaigne.

It may be said, in fact it has been said, that these osseous changes are the results of the continuance of a lateral curvation produced by other causes.

I have already pointed out that they exist from the very first; therefore the influence of the other causes on the shapes of the bones must be practically instantaneous. Let us consider what these other causes are said to be, and then try if they can do what they are credited with.

1st. We are constantly told that faulty positions, if habitual, will produce scoliosis. And among the chief agencies which produce these habitually wrong positions the greatest stress is laid on (1) muscular weakness, (2) inequality in length of the lower limbs. (3) the practice of carrying weights on one shoulder or one arm. With regard to muscular weakness, it does not exist in a very marked degree at the onset of scoliosis. In many cases it does not exist at all; on the contrary considerable and even exceptional muscular vigor is occasionally coincident with progressing lateral curvature, and, which is more to the point, it has never yet been shewn that such weakness as is sometimes found is not the result rather than the cause of the disease. By "the disease," I do not mean the deformity, but the essential disorder which possibly exists and causes both the deformity and the muscular weakness. Moreover, let us remember the countless number of instances of great and prolonged muscular weakness which everybody may see absolutely uncomplicated with deformity of the spine. How small is the proportion even of young people, who when convalescent from fevers or whilst exhausted with long chronic illness, or who from congenital want of vigor have to crawl feebly through life, how small is the proportion of such in whom true scoliosis may be detected. Perhaps it may be urged that this is merely because some exciting cause is wanting. But what are the exciting causes most favored by the muscular-mechanical theorists? They are inequality in the length of the lower limbs, and habits of lazy or sidelong sitting, standing, and the like.

Now the class of weak young people I have just referred to, is crowded with individuals who from hip or knee disease habitually walk and even sit with a laterally curved spine; it is crowded also with persons who are clerks, pupil-teachers and the like, because they are fit for nothing which makes greater demands on the physical strength. It is crowded with

seamstresses and machinists who habitually sit to one side, with shop-girls who are always reaching up to high shelves with the right hand, or standing at ease on one leg; yet it would be a monstrous and palpable misstatement to say that any but a small minority of these people are scoliotic.

It may be replied "exactly so, it is only persons who are subject to an *excess* of the influences in question who get lateral curvature." This statement is as baseless as the rest. There happens to be a class of so-called "hysterical" people, who will loll all day long for years with their backs arched sideways almost to a semicircle, fancying they have lateral curvature, and frequently encouraged in this fancy by mistaken medical men. Often these young women have very weak muscles. But it is the rare exception for anything like genuine scoliosis with its osseous deformity to supervene. Now how could any mere statical arrangement be devised more favorable for putting to the test the theory I am attacking, than that a weakly young woman should keep up for hours, days, and years, (at least when observed), a position like that just noticed?

Then again, with regard to inequality of the lower limbs, long series of cases come under my observation, of persons with one leg, three, four, five, six, seven, etc., inches shorter than the other, usually from disease, sometimes from congenital peculiarity, and it is rare indeed to find one of them with scoliosis. In most of these cases, the inequality has existed for years at the very age at which scoliosis usually develops.

Lastly with regard to carrying and lifting weights almost exclusively with one arm, who is there who works at all, whether scoliotic or not, who does not use one arm more than the other? When we are told that a certain nurse-maid contracted lateral curvature from always carrying the child on one arm, let us ask ourselves have we any reason whatever to assert or think that non-scoliotic nursemaids are free from any partiality for one arm or the other. How many young blacksmiths become scoliotic from using, as they do, the small hammer, almost exclusively with the right hand? It has been said that their muscular development protects them. But it does not protect them from knock-knee and flat-foot. And, indeed, they do occasionally have lateral curvature like other people,

but only like other people. Let us remember also that the young women who form the largest proportion of scoliotics are not given to using either arm very much.

2nd. Lateral curvature has been attributed to an absence of balance between the strength of the muscles acting on opposite sides of the spine.

Now, in an ordinary case, the most careful examination will fail to detect any sign of such an inequality. And, moreover, in the rare cases where such an inequality undoubtedly exists, namely in cases of hemiplegia, it is not usual for lateral curvature to supervene, or it may supervene but in the opposite direction to that in which it should occur according to this the so called "antagonistic theory." Moreover, although it is impossible to find any noticeable asymmetry as regards the muscular strength of the trunk, we may, as the parts of the body are scarcely ever perfectly symmetrical, be sure that some degree is almost always present in non-scoliotic as well as in scoliotic persons.

In short, no mere mechanical or muscular theory will account for scoliosis as we ordinarily meet with it. We must not allow ourselves to be misled by any teaching of the kind, if we are ever to get at the true etiology and pathology of the disease.

Upon reflection we are struck with several facts which may not improbably. have, individually or collectively,an important bearing on the question. In the first place the deformity begins almost always either during early childhood or between the ages of eight and sixteen or seventeen. In the former case its rachitic origin is undoubted. In the latter case it commences at a time of life marked by the approach or onset of puberty, the very great majority of the persons attacked are females. Putting aside for the moment the difficult question of the real or imagined relations between syphilis and rickets, the latter may be described as a disease of nutrition and growth of the osseous system. It will be granted also that the nature and amount of the food have a great influence on the course of rickets, even if faults in the matter of diet are not wholly responsible for its onset. I am not acquainted with any inquiry, if such have ever been made, into the dietetic habits of adolescents with lateral curvature.

It would be worth making, though perhaps difficult. Young girls of the upper and middle classes, who furnish so large a relative proportion of scoliotics are certainly given, for æsthetic and fashionable reasons, to playing tricks with their diet, to eating irregularly, even if not insufficiently, and especially to the avoidance of what they are pleased to consider coarse feeding.

It is not impossible that in their anxiety about their skins, they may unwittingly starve their bones. It is not,however necessary to detect error in what actually enters the stomachs of adolescent scoliotics. Nutrition being a very compound function, it may be said that not only is there many a slip 'twixt the cup and the lip, but there are many more beteen the lip and the blood. Now a disordered nervous, especially a troubled vaso-motor, system is particularly likely to cause slips of the latter kind, that is to say prevent even the best of food from building up sound blood, bone, and other tissues.

Puberty and the few years which precede and follow it constitute the time of all others when such nutritive disorders such nervous troubles are rife. They show themselves superficially in the form of cold extremities, of chilblains, of acne-covered faces and backs, of lusterless hair, of wet palms and soles, of chlorosis, and of some of the well known signs of of mental and spiritual discomfort characteristic of the hobble-de-hoy, and of the bread-and-butter Miss. I am speaking of these as "superficial" symptoms, but they are obviously significant of profounder changes. When the gums are chlorotic the lungs are not less so.

When the circulation in the feet swerves at the slightest provocation from the even tenor of its way, it may be just as irresolute in the liver, or the kidneys. All this points to the probability of disordered nutrition of the bones, the parts primarily affected in true scoliosis, being of the very essence of the disease. But, having got so far, we are still far indeed from complete knowledge. Why do only a limited number of wrongly fed infants get rickets? Why do only a small proportion of young people at or near puberty suffer from disordered nutrition of the bones?

The whole answer to these questions has yet to be worked out. Various guesses have been made; but mere guesses they still remain. It would be strange if masturbation, the universal scapegoat for the pathological errors of adolescence, had not been pitched upon. Accordingly we find that Mr. Clement Lucas, has scarcely a doubt upon the point. In his eyes the knock-knee, and the scoliotic back appearing about puberty, are as pathognomonic as the shame-faced glance, the dull eye, the spiritless manner, and the other little signs that together make up a picture which, it cannot be denied, all who run may read. But when one comes to examine either Mr. Lucas's argument, or Dr. Moxon's paper, to which he refers us, we see that it is but guessing again, and that all the difficulties of a most difficult question are simply evaded. For instance, let each of my readers run over in his own mind the number of persons whom he *knows* to have been guilty of self-abuse, and then ask himself how many have lateral curvature or knock-knee? Even as I write this, I pause and, without an effort, recall more than twenty, who have confessed to an excessive addiction to the practice throughout youth, and every one is straight in trunk and limb, excepting a case or two of slight kyphosis.

But we know that the vice in question is even more common among the poor than among the rich, and quite as common among young boys as among young girls. How do these facts fall in with the proportionate liability of these classes to scoliosis? Nevertheless, the mere fact that a grave vice, well known to be capable of seriously impairing nutrition, is most common at the age at which the rickets of adolescents occurs, is to be well remembered in the study of the affection.

A cause may be a true cause and yet act only exceptionally. For instance, masturbation is an undoubted cause of insanity, but only in the case of a small proportion of offenders. On the other hand lateral curvature is frequently seen commencing in young people with frank, innocent bright looks practically beyond suspicion. Many such are not more than five, ten, or twelve years of age. To sum up, the essential nature and causes of scoliosis are not known with certainty aad invite inquiry. But facts point very strongly towards the probability of a disturbed nutrition of the ossifying cartilages and of the

bones of the spine being a necessary factor in the production, and this disturbed nutrition is not secondary to any such coarse mechanical influence as, for example, a habit of sitting or standing with the spine arched sideways.

Next we have to ask ourselves,do such mechanical influences as those I have just mentioned play any part in the etiology, and, if they do, *what* part?

Once again let us try to realize how utterly unscientific is the practice of saying, "so-and-so used to carry a heavy bag with one hand or to regularly practice on the violin, and consequently he got a lateral curvature of the spine." How surgeons can write and talk like this when any evening they may go to a theatre and see a dozen straight-backed musicians who have all fiddled away for their daily bread from their boyhood upwards, is really astonishing.

But this slipshod style of inference is not necessary to prove that statical forces do, almost certainly, play a part in the causation of scoliosis.

In almost every instance of this deformity there is more than one curve in the spine. And the successive curves always alternate. See Fig. 4. Now if the affection were purely one of defective nutrition, or other form of tissue-disease, it would be in the highest degree unlikely that the vertebræ most affected, most altered in shape, namely those at A, B and C, would always be found to occur in alternating sets, thinned first on the left side, then on the right, and so on. We seek in vain for any anatomical facts to explain the regular alternation, and when it is remembered that the positions of the different curves vary almost infinitely in different cases, it is clear that a mere anatomical explanation is not very likely to be possible. On the other hand the statics of the spine give a reason at once ready, satisfactory, and not inconsistent with what else is known about the matter. We shall return to this subject when writing of secondary or "compensatory" curves. In genu valgum, a compensatory and secondary curve inwards of the ankle takes place. It brings the foot flat to the ground. Now comes the question, *what* part do statical forces play?

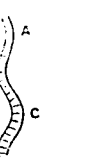

Fig. 4.

Do they deserve to rank with the rachitic affection itself, are they more important or quite subordinate? This question has a distinct bearing on practice, as we shall see by and by.

I am scarcely inclined to go with Professor Bush, of Berlin, who writes of the rachitis as a mere predisponent and of the statical or "pressure" forces as the causes. The latter are so common, in fact they are universally existent in some degree, and yet it is seldom that they produce scoliosis. On the other hand does rachitis of the adolescent spine ever exist without causing scoliosis? That is a difficult question to answer in the negative, but it is enough for my argument, that it is equally difficult to answer in the affirmative. When an ill made pudding falls in pieces, we do not blame the universal force of gravity. We fix our attention on the faulty preparation of the pudding.

That statics play a part in determining the direction of each curve may be regarded as certain, that they play a part in fixing the position of the center of each curve is almost equally certain, that they have a great deal to do with regulating the intensity of each curve is likely enough, but by no means certain. Before passing to simple anatomical description a few other points should be noticed bearing on etiology.

I have mentioned already the ages at which scoliosis usually supervenes, namely (1) early childhood; first to fourth or fifth year. (2) eighth to fourteenth year or later, (3) after the fiftieth year. The last class of cases rarely actually originate in advanced life. But they may have been stationary throughout the prime of life, and, in old age, commence to get worse.

Such cases are usually complicated with kyphosis, sometimes to a very marked degree. With regard to sex, in early childhood, the proportions are always equal. In adolescence and old age the females greatly outnumber the males, (5 or 6 to 1.) This fact suggests a relationship of the cause of scoliosis to the sexual changes about this period far more impressive in the female than in the male organism. On the other hand it does not suggest a special connection between scoliosis and moral vice of a certain kind.

The various influences which may injure the constitution during infancy and youth act at least indirectly as causes of scoliosis by predisposing to or actually producing rachitis either of infants or adolescents, and possibly in other ways.

It is not uncommon to find more than one case of scoliosis

in the same family. I occasionally see three sisters all scoliotic, and with a considerable degree of kyphosis. There appears therefore to be, at least, an occasional hereditary tendency to scoliosis.

Cases of scoliosis occur in which the mechanical origin is beyond doubt; but they are rare; and such as I have seen present marked differences from ordinary scoliosis. Among such mechanical causes are cicatricial bands, injuries to the spine, the pressure of tumors, and contraction of one side of the thorax consequent on empyema. I know personally of no case of lateral deformity of the spine due to any of these causes, except cicatricial contraction after burns of the neck and lateral curvature after empyma. Even when powerful mechanical influences such as the above act, the deformity only exceptionally assumes a form similar to that of true scoliosis. Lateral inclination of the spine starting at the point of disease, is not uncommon in cases of caries, especially lumbar caries. The statical inclinations which play a certain though limited part in the etiology of scoliosis may be referred to two classes of influences, namely (A) Those which disturb directly the equilibrium of the body above the pelvis, and (B) those which directly raise or lower one side of the pelvis above the other side.

Class (A) includes the loss of one arm, inequality of the arms, paralysis of one arm, (causing it to hang like a dead weight,) alteration in the size of one or more of the viscera, and development of a tumor laterally. Class (B) is for practical purposes confined to deformities, deficiencies, etc., of the lower limb or limbs.

It includes amputations, dislocations, permanent flexions, anchyloses, arrested development, club foot, paralyses, unsymmetrical rachitic curves, and the like.

It should not be forgotten that scoliosis occurs in animals, such as the horse, which walk on all fours, and also in fishes. A scoliotic gold fish was to be seen swimming in a bowl for some years, up to the present (1887) in the "male accident-"ward at the West London. Cases have been recorded in which scoliosis appeared to have had a rheumatic origin. Among attitudes and actions favorable to the developement of scolio-

sis have been enumerated carrying weights always on one arm, working excessively with one arm or one leg, harp-playing, fiddling, embroidering and sewing with machines, writing and drawing.

I hope that the appeal which I have already made to my reader's common-sense will have prepared him to endorse what Bouvier and Bouland have to say about these occupations. "The influence of these on young girls has been much exaggerated.

It is only in particular cases and when they have been pushed to extremes, that they appear to really concur in the production of scoliosis." Mark the caution of the expression, "they *appear to* really *concur*, in the production," not "they produce."

The etiology of congenital scoliosis is quite special, and all the above remarks apply to it, little if at all. It is associated with other grave defects constituting a peculiar kind of monstrosity.